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Review Article

Carpal tunnel syndrome – Part II (treatment)^{☆,☆☆}

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ABSTRACT

The treatments for non-deficit forms of carpal tunnel syndrome (CTS) are corticoid infiltration and/or a nighttime immobilization brace. Surgical treatment, which includes sectioning the retinaculum of the flexors (retinaculotomy), is indicated in cases of resistance to conservative treatment in deficit forms or, more frequently, in acute forms. In minimally invasive techniques (endoscopy and mini-open), and even though the learning curve is longer, it seems that functional recovery occurs earlier than in the classical surgery, but with identical long-term results. The choice depends on the surgeon, patient, severity, etiology and availability of material. The results are satisfactory in close to 90% of the cases. Recovery of strength requires four to six months after regression of the pain of pillar pain type. This surgery has the reputation of being benign and has a complication rate of 0.2–0.5%.

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Síndrome do túnel do carpo – Parte II (tratamento)

RESUMO

Os tratamentos nas formas não deficitárias da síndrome do túnel do carpo (SCC) são a infiltração de corticoide e/ou uma órtese de imobilização noturna. O tratamento cirúrgico, que compreende a secção do retináculo dos flexores (retinaculotomia), é indicado em caso de resistência ao tratamento conservador nas formas deficitárias ou, mais frequentemente, nas formas agudas. Nas técnicas minimamente invasivas (endoscópica e *miniopen*), independentemente de a curva de aprendizado ser mais longa, parece que a recuperação funcional é mais precoce em relação à cirurgia clássica, mas com os resultados em longo prazo idênticos. A escolha depende do cirurgião, do paciente, da gravidade, da etiologia e da

Palavras-chave:

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disponibilidade do material. Os resultados são próximos de 90% de casos satisfatórios. A recuperação da força necessita de quatro a seis meses após a regressão das dores do tipo dor do pilar (*pillar pain*). Essa cirurgia tem a reputação de ser benigna e apresenta de 0.2% a 0.5% de complicações.

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Introduction

The first operation in which the anterior annular ligament of the carpus was sectioned is attributed by Amadio,¹ a Canadian orthopedist, to Herbert Peter H. Galloway, who, on March 11, 1924, performed exploration of the median nerve at the carpal tunnel through an incision of 2.5 cm distally and 5 cm proximally from the wrist flexion crease, in a patient with thenar atrophy and anesthesia of the index finger and thumb, subsequent to wrist compression. Although the patient recovered sensitivity of the index finger, she developed painful flexed contracture of the wrist, which was initially correlated with a neuroma of the cutaneous branch of the median nerve.

Treatment

Conservative treatment

In relation to corticoid injection, immobilization by means of orthotic braces and oral corticoid therapy, the level of evidence is sufficient to confirm their effectiveness. There is controversy in relation to other treatments (ultrasound, laser, diuretics, vitamin B6 therapy and weight loss). There are no recommendations with scientific proof, and no consensuses in the literature, regarding the strategy to adopt.^{2,3}

Local injection of corticoid

The action implemented through local corticoid injection comprises reduction of the tenosynovial volume, with a direct effect on the median nerve. The main risk is injury to the median nerve, which is very painful, with the sensation of an electric shock and the risk of developing a neurological deficit and persistent pain. Another complication is the risk of tearing the tendon.

We use an injection point located from 4 cm proximally to the wrist flexion crease to halfway between the tendon of the long palmar muscle and the ulnar flexor of the carpus, which is an extension of the axis of the fourth finger. After performing local antisepsis, the needle is slowly inserted obliquely, at 45° to the carpal tunnel. There should not be any abnormal resistance. The other hand is used to check that the needle is not in the region between the tendons, and the fingers are passively mobilized. Following this, the injection is made slowly. A transitory painful reaction may occur a few hours after the injection.

Injection between the radial flexor of the carpus and the long palmar muscle causes injury to the median nerve, given the position of the nerve. Dreano et al.⁴ made the injection on

the ulnar side of the long palmar muscle. Dubert and Racasan⁵ reported measurements from the median nerve to the tendons of the long palmar muscle, radial flexor of the carpus and ulnar flexor of the carpus, which were made 1 cm proximally to the wrist flexion crease. They identified a risk zone covering an area up to 1 cm on each side of the long palmar tendon. They advised making the injection through the radial flexor of the carpus at an angle of 45° distally and 45° to the ulna. There would be no difference between an injection made 1 to 4 cm proximally and an injection at the wrist flexion crease.⁶

Relief is observed starting between a few days and two to three weeks after the application. Local injection of corticosteroids has significantly greater efficacy than does injection of placebo after one month, and its effect lasts longer than that of oral corticoid therapy over two to three months.⁷ Temporary relief after local corticoid injection is a good prognostic sign for surgical treatment.⁸ Two injections do not have greater efficacy than one injection alone. More than three injections are not advisable. The minimum recommended time between two injections is one month. Diabetes mellitus is a contraindication. In cases of intermittent carpal tunnel syndrome (CTS) without any deficit, Agarwal et al.⁹ found that 93.7% showed improvement clinically and on electroneuromyography (ENMG) after three months, and 79% after 16 months, with 50% showing normalization of ENMG. In a series of patients with or without deficit who were treated by means of infiltration and use of orthotic braces for three weeks and followed up for six to 26 months, Gelberman et al.¹⁰ found that only 22% did not present symptoms at the maximum regression. The criteria for a good prognosis consist of presentation of symptoms for less than one year and absence of motor or sensory deficit.

Nocturnal immobilization braces with the wrist in neutral position

It has been demonstrated that the pressure in the carpal tunnel increases with extension and flexion of the wrist.^{11,12} The position of the wrist fixed to the splint should be in a strict neutral position in order to diminish the pressure inside the canals. The orthotic brace should be made to measure and be appropriate for any coexisting pathological conditions (e.g., rhizarthrosis). At most, the result from this treatment seems to be equivalent to corticosteroid injection.¹³ Stutzmann et al.¹⁴ found that 81% of cases of moderate CTS presented relief within three years. The duration of the treatment is from three weeks to three months. The orthotic brace can be used in association with infiltration.

Modification of mechanical and ergonomic measurements

Reduction of activity, at least temporarily, often allows relief. This is particularly so in CTS cases in men after excessive manual labor.

On ergonomic keyboards, no significant difference in terms of improvement of symptoms and abnormalities on ENMG was found in relation to traditional keyboards, among patients with proven CTS.¹⁵

Surgical treatment

The principle of surgical treatment is to achieve a reduction in intratunnel pressure through increasing the volume of the carpal tunnel, by sectioning the flexor retinaculum. The procedure is done under locoregional or local anesthesia, ideally as an outpatient procedure, and frequently using a tourniquet. The procedure is generally unilateral. Three techniques are currently used:

- Open procedures;
- Techniques known as “mini-open”;
- Endoscopic techniques.

Care is required in order to avoid placing the median nerve at the extension of the incision scar, so as to minimize the postoperative epineural adhesences.

Anesthesia and carpal tunnel surgery

Carpal tunnel surgery can be performed under local, locoregional or general anesthesia. In cases of local anesthesia, tolerance of the tourniquet is the main limiting factor. Regarding locoregional anesthesia through blocking the median, ulnar and musculocutaneous trunks, the tolerance of the blocks seems to be worse in the wrist than in the brachial canal.¹⁶

Infiltration into the carpal tunnel in association with infiltration into the subcutaneous tissue at the level of the incision¹⁷ provides greater relief for patients during and after the operation than does subcutaneous infiltration alone.¹⁸ The tourniquet is inflated after the injection. Use of epinephrine would avoid the need for a tourniquet.

For endoscopic surgery, median, ulnar and musculocutaneous distal trunks blocks implemented 6 cm proximally to the wrist flexion crease may avoid soft-tissue infiltration and have a considerable influence on endoscopy. According to Delaunay and Chelly,¹⁹ after 10 min, 9% and 32% of the patients required additional anesthesia at the levels of the median and ulnar nerves. No partial or total neurological deficits were observed after the operation.

Open technique

The open technique is the oldest form of treatment. An incision of 3–4 cm is made, extending from the wrist flexion crease along the prolongation of the radial edge of the fourth finger to Kaplan's cardinal line. The fat pad of the hypothenar region²⁰ is interposed at the end of the surgery between the skin and the flexor retinaculum. Following this, the middle

palmar aponeurosis is incised radially. Subcutaneous dissection preserving the sensory branches that are susceptible to creating postoperative pain was not shown to be superior to direct incision of the flexor retinaculum using a scalpel.²¹ Hemostasis through bipolar coagulation is a requirement.

The flexor retinaculum is exposed using separators. The dissection forceps identify the hamate hook. The middle part of the flexor retinaculum is then incised on the ulnar side of the axis, in the fourth finger, and an ulnar margin is left in order to limit the subluxation of the flexors. Sectioning of the flexor retinaculum continues cautiously in the distal direction until reaching the superficial palmar arch and the median-ulnar anastomosis. Proximally, the flexor retinaculum is separated at deep levels from the synovium of the flexors, using dissection scissors. The content of the carpal tunnel is ascertained in terms of muscle abnormalities and the appearance of the synovium. To view of the median nerve, the radial edge of the flexor retinaculum needs to be carefully raised using a separator. The median nerve is the most superficial and radial element. The skin is then closed.

Associated procedures

- Synovectomy of the flexors: this is no longer systematically done or necessary. Biopsy may be justified in cases of doubt regarding secondary synovitis. In the event that extensive synovectomy is needed, the proximal cutaneous incision is extended to the distal part of the forearm, using a separator at the wrist flexion crease.
- Epineurotomy of the median nerve: this is not superior^{22–24} and is no longer recommended, even in situations of deficit. Endoneurolysis is not recommended in primary surgery, because of the risks of adhesences and devascularization.^{25,26}
- Exploration of the thenar branch: the only justification for this in a primary surgery is in cases of extensive synovectomy of the flexors due to anatomical variations and in cases of isolated motor deficiency.
- Release of Guyon's canal in cases of acroparesthesia of the fifth finger: In the absence of compression of the ulnar nerve in the wrist that is proven clinically and via ENMG, Guyon release is not recommended. Ulnar-median anastomoses may be implicated if there is no compression of the ulnar nerve in the elbow or any proximal pathological condition (in the cervical spine or spinal cord). Carpal tunnel surgery enables improvement of the symptoms.²⁷ Moreover, after endoscopic or open surgery, the pressure on Guyon's canal decreases by two thirds.²⁸
- Reconstruction of the flexor retinaculum: the aim is to reduce the duration of loss of strength after the surgery, the risk of subluxation of the flexors of the fingers and the presence of spinal pain. Several techniques have been proposed,²⁹ using Z-plasty, VY, zigzag incisions with dome sutures, radial tabs from a proximal pedicle or the plasty of Jakab et al.³⁰ (which was the method preferred by Foucher et al.³¹), with vertex sutures using a flap from a distal radial pedicle and another from an ulnar pedicle, plasty and folding of the flexor retinaculum. Only one methodologically satisfactory paper on patients with bilateral carpal tunnel syndrome has been published, and it did not show

any difference between those who were operated classically and those who underwent stretching of the flexor retinaculum.³² More recently, treatment consisting of an implant of silicone and polyethylene terephthalate, sutured using flaps from the flexor retinaculum, was proposed. Two groups of 400 patients were compared, and the group with the implant was found to have faster recovery of strength.³³ Five implants had to be removed.

- Transfer of thumb opposition (Camitz technique):³⁴ in atrophic forms with a deficit of opposition, it is possible to simultaneously perform release of the median nerve and transfer of opposition. This indication is rare, since the short flexor of the thumb receives ulnar innervation and, despite the evident thenar atrophy, this enables sufficient opposition. If the opposition is insufficient, the long palmar muscle is extended to part of the superficial palmar aponeurosis and can be used as a transfer over the short abductor of the thumb, as was proposed by Littler and Li.³⁵

Techniques described as “mini-open”

- Mini-open technique with incision close to the flexor retinaculum:^{36,37} a cutaneous incision of 1–1.5 cm is made in the distal part of the flexor retinaculum, starting from Kaplan’s cardinal line, on the axis of the radial edge of the fourth finger. The flexor retinaculum is then incised distally, in the distal-to-proximal direction using scissors by means of spacers, as far as the proximal part. A series published in 2003 did not present better results.³⁶
- Mini-open technique with incision at the wrist flexion crease: the flexor retinaculum is not viewed and there is no interposition, with a potential risk of iatrogenic injury and/or incomplete sectioning of the flexor retinaculum. Paine and Polyzoidis³⁸ used a “retinaculotome” to protect the content of the carpal tunnel. Durandeau³⁹ used a probe channel for this function and this is the preferred technique.
- Mini-open technique with double edges: with a distal edge to help protect the neurovascular elements. The flexor retinaculum is again not view, except when sectioned. The techniques of Chaise et al.⁴⁰ and Bowers as mentioned by Beckenbaugh⁴¹ can be cited, with the addition of a proximal incision, 1 cm distally from the hamate hook, with a protection retractor. Lee and Strickland⁴² used a special scalpel with transillumination.

Endoscopic surgery on the carpal tunnel

Endoscopic surgery on the carpal tunnel was started in Japan by Okutsu,⁴³ and then in the United States by Chow.⁴⁴ Chow’s technique involves two surgical approaches, and complications inherent to the distal incision have limited its use, thus favoring the technique of Agee et al.,⁴⁵ which uses a single proximal incision. Furthermore, because the wrist is placed in hyperextension in Chow’s technique, the intratunnel pressure is considerably increased, which may cause acute compression of the median nerve before the operation. A longer learning curve is required.

Agee’s technique

Agee’s technique is the one that is used most, performed under regional anesthesia after performing local antiseptics. The approach route is of length 1 cm, at a distance of 0.5–1.0 cm proximally to the wrist flexion crease, over the ulnar edge of the long palmar muscle. The subcutaneous dissection makes it possible to expose the fascia of the forearm. It needs to be checked whether the incision is in the extrabursal space. A disposable blade is used, lubricated on its deep surface to facilitate its introduction, which is done on the axis of the fourth finger. Progression of the incision is slow, under endoscopic control, by means of sliding the disposable blade against the deep surface of the flexor retinaculum. If viewing is imperfect or introduction of the instrument is difficult, the operation should be converted into an open procedure. The patient should be informed about the possibility of conversion before the procedure is started. The incision should progress until the distal fat pad is seen. Sectioning of the flexor retinaculum is started distally, level with the fat pad.

Postoperative period

Finger mobilization is possible starting in the immediate postoperative period. The stitches can be removed from the 15th day onwards. Activities requiring force are reintroduced partially after three weeks and completely after six to eight weeks. Some authors have advised using postoperative bandaging for two to three weeks, with the aims of diminishing pillar pain⁴⁶ and providing better healing of the flexor retinaculum. On the other hand, immobilization may favor postoperative epineural adhesences. The superiority of this immobilization was demonstrated by Finsen et al.⁴⁷ and Bury et al.,⁴⁸ thereby disagreeing with Chaise.⁴⁹

Results from carpal tunnel surgery

Favorable evolution

In the great majority of cases, the evolution is favorable, with disappearance of the paresthesia during the postoperative period (Lundborg’s early phase). In cases of alterations of the myelin sheath (intermediate phase), intermittent paresthesia may persist for a few days. If there was a preoperative deficit (advanced phase), discriminative sensitivity is recovered within a few weeks to some months. Depending on the severity, dysesthesia may persist throughout the recovery period. On the other hand, motor recovery and recoveries of the atrophy are random and are generally not seen in elderly patients. During the healing of the flexor retinaculum, the pain and edema in the area that was sectioned regress in four to eight weeks. It takes two to three months to recover strength.

The amount of sick leave allowed varies according to the type of activity and the professional sector. In 2001, Chaise et al.⁴⁰ evaluated the length of time off work after carpal tunnel surgery performed using two approaches: without endoscopy and with postoperative immobilization for 21 days. For non-employed individuals, the mean was 17 days off; for private sector employees, 35 days; and for public sector employees, 56 days. Manual workers were given a mean length

of sick leave of 29 days if they were non-employed, 42 days if they were private-sector employees and 63 days if they were public sector employees.

Prognostic factors

In an analysis of the literature, Turner et al.⁵⁰ found that the worse results were observed in the following cases:

- Diabetes mellitus with polyneuropathy and impaired general condition;
- Use of alcohol and tobacco;
- Preoperative normal ENMG results;
- Occupational diseases;
- Thenar amyotrophy;
- Multiple nerve compression syndromes.

Comparisons between open, mini-open and endoscopic surgery

Both open and endoscopic techniques are widely used. Increased carpal tunnel volume has been observed independently of the technique used for sectioning the flexor retinaculum. After open surgery, an increase in volume of $24.2 \pm 11.6\%$ was observed, with palmar displacement of the content of $3.5 \pm 1.9\text{ mm}$.⁵¹ After endoscopic surgery, the increase in the sectioned area was estimated as $33 \pm 15\%$.⁵²

Safety, efficacy, morbidity, cost and time taken to return to preoperative activities have been compared. The learning curve is longer for endoscopic surgery. One study found that, one year after the operation, there was no difference between the two techniques.⁵³ On the other hand, some studies have demonstrated that endoscopic surgery enables earlier functional recovery, especially over the first three months.^{31,54-57} Pain at the site of the surgery has been less observed after Atroshi's endoscopy.^{58,59} Eight studies out of 14 showed that there was a faster return to work after endoscopy, with a difference of between six and 25 days.⁶⁰ However, this continues to be a matter of controversy, such that there are studies showing that each of the techniques was superior to the other one.⁶¹

Few studies have compared endoscopy with the mini-open technique, and the results have either been identical or have favored endoscopic surgery regarding postoperative pain.⁶⁰ According to Wong et al.,⁶² the technique of Lee and Strickland⁴² seemed to lead to less postoperative pain than did Chow's endoscopic technique.

In comparing conventional surgery with the mini-open technique, the results are inconclusive, with some short-term advantages for the mini-open procedure.⁶⁰ On the other hand, the risk of incomplete sectioning of the flexor retinaculum is higher with the mini-open technique.⁶³

The choice between open, mini-open or endoscopic surgery depends on the surgeon's preferences and habits,⁶⁴ the information available to the patient, the type of CTS, its etiology and the availability of equipment.

Complications from surgical treatment of CTS

The minor complications need to be distinguished from the severe complications.

Minor complications

Neurogenic pain in the scar

Four nerve branches involved in innervation of the palm of the hand at the level of the thenar and hypothenar eminences are considered to be at risk in making an incision in the carpal tunnel.⁶⁵ Some of these branches may cross the line that passes along the radial edge of the fourth finger. These branches may become injured through the incision and result in scar pain of neuromatous syndrome type.

- The palmar cutaneous branch of the median nerve;
- The palmar cutaneous branch of the ulnar nerve, which emerges around 4.6 cm proximally to the pisiform bone;
- The Henlé nerve or *nervi vasorum* of the ulnar artery, which participates in the innervation of the hypothenar eminence in 40% of the cases;
- The palmar transverse branches of the ulnar nerve, which originate in Guyon's canal and innervate the skin in the hypothenar eminence and palm of the hand, in the area of the palmar cutaneous branch of the ulnar nerve and Henlé nerve.

These pains are not normally observed after endoscopic surgery. Even with the classical incision of the carpal tunnel that is recommended for the prolongation of the radial edge of the fourth finger, there is no absolute safety zone, given the overlapping of the areas of proximal innervation.^{65,66} Ozcanli advocated the mini-open technique with an incision in the distal part of the flexor retinaculum between the superficial palmar arch and the distal part of area of the palmar cutaneous branch of the median nerve, as presenting less risk of lesions in the superficial nerve ramifications.⁶⁷ However, it has not been demonstrated that the access opened in the mini-open technique, in the distal part of the flexor retinaculum, is free from this type of complication.³⁶

Pillar pain or pain at the ulnar edge⁴⁶

Postoperative pain at the level of the hypothenar eminence and, by analogy, at the level of the thenar eminence, is expected in the initial phase. There is concomitant edema in relation to the flexor retinaculum. Clinical persistence as problems in recovering activity levels, with loss of strength, is fortunately less frequent (1-36% of the cases)^{46,68} and this may be observed independently of the type of surgery.^{36,68} The pain is related to the insertions of the thenar and hypothenar muscles at the edges of the flexor retinaculum, approximately at the level of the pisiform-triquetral joint, even with minimal manual activities. The edema relating to sectioning the flexor retinaculum generally diminishes concomitantly with improvement of the pillar pain. It has not been demonstrated that postoperative immobilization prevent this complication.^{47,48} It is treated through new immobilization, reduction of activities and symptomatic treatment with corticoid infiltration.

Algoneurodystrophy

Algoneurodystrophy is less common because of advances in anesthetic and analgesic techniques. Postoperative pain is an important generating factor. The more severe forms may be

associated with bruising or acute compression of the median nerve over the course of the operation.

Instability of the ulnar flexor tendons through sectioning the flexor retinaculum

Instability of the ulnar flexor tendons is marked by severe pain on the ulnar edge of the carpal tunnel, which returns to the forearm on the path of the ulnar flexor of the fingers. Sectioning of the flexor retinaculum leaving a flap over the hamate hook reduces the frequency. Persistence is rare. This is exceptionally observed after endoscopic surgery, caused by the size of the endoscope, and leaves an edge of the flexor retinaculum on the ulnar side. Reconstruction of the flexor retinaculum theoretically makes it possible to avoid this process.

Complications of greater severity

Complications of greater severity are rare. This is emphasized by the fact that this surgery, in the minds of the present-day population, is associated with highly satisfactory results. In a review of the literature covering the period 1966–2001 for open surgery and 1989–2001 for endoscopic surgery, Benson et al.⁶⁹ found that the rate of severe complications was 0.49% for open surgery and 0.19% for endoscopy. Prevention should be prioritized, especially in cases of endoscopic or mini-open surgery.

Nerve complications: These consist of transitory neuropraxia (1.45% after endoscopy and 0.5% after open surgery), partial or complete sectioning of the median or ulnar nerve (0.14% during endoscopy and 0.11% during open surgery) or of their branches (0.03% during endoscopy and 0.39% during open surgery).⁶⁹ Lesions of the common palmar digital nerve of the third space and of the communicating branch between the common palmar digital nerve of the third and fourth spaces can particularly be cited. These may be injured in endoscopic surgery with two incision routes or in mini-open surgery. The anastomosed branch is located between 2.3 and 10 mm from the distal edge of the flexor retinaculum.⁷⁰ In cases of partial or total sectioning of the nerve, the result from surgical treatment, which should be performed early on, is incomplete, with some severe and definitive residual pains.

Injury to the superficial vascular arch

Injury to the superficial vascular arch is reported in 0.02% of the cases.⁶⁹ The superficial vascular arch is close to the distal edge of the flexor retinaculum. Both methods enable identification of its cutaneous projection.

- **Kaplan's cardinal line:** This was described by Kaplan in 1953. It starts from the deepest point of the first commissure and heads toward the ulnar side of the hand, parallel to the proximal palmar crease. The superficial palmar arch is located at least 7 mm from Kaplan's line on the axis of the radial edge of the fourth finger.⁷¹ The point of muscle penetration of the thenar branch is located between 0.1 and 1.5 cm proximally, along the projection of the radial edge of the third finger.
- **Cobb's marks:** These make it possible to better locate the hamate hook,⁷² given that they do not depend on possible trapeziometacarpal stiffness. The hook is at the intersection point between two lines: one from the pisiform bone

to the proximal palmar crease in relation to the axis of the index finger; and the other joining the middle of the base of the fourth finger to the union of the middle third and medial third of the wrist flexion crease. The superficial palmar arch is at a mean distance of 2.7 cm (range: 1.8–4.5 cm) distally from the hook.

Sectioning of the flexor tendons of the fingers.

Sectioning of the flexor tendons of the fingers has been reported after endoscopic surgery (0.008%).⁶⁹

Information for patients

The surgeon needs to be able to prove that he really gave information to his patient. Provision of preoperative information is legally indispensable, even if it is poorly retained by the patient.⁷³ This can be done orally, but it is difficult to prove. The best way is to give information orally and in writing, using an informed consent form that mentions the complications, even if these are exceptional. A summary of the key elements to be included was proposed by Goubier et al.⁷⁴ In 2000, Julliard⁷⁵ observed that almost three quarters of the processes were consecutive and that one quarter of the procedures were poorly justified due to technical failures: sectioning of nerves, infection, ineffective reintervention, etc.

Therapeutic indications in CTS cases

Acute CTS

Post-traumatic: These cases essentially occur after fracturing of the distal radius or perilunate dislocation of the carpus. Compression that worsens progressively needs to be distinguished from bruising with emblematic symptoms and little edema, which in principle does not require surgical treatment. In cases of compression without signs of deficit, urgent reduction of the displacement is often sufficient for the symptoms and compression to regress. In cases of forms of deficit or significant edema, urgent surgical treatment is necessary. There is room for open surgery.

Non-traumatic: Urgent surgical treatment is necessary

Subacute or chronic CTS

Non-surgical first-intention treatment is indicated in early forms. In intermediate forms, with nocturnal and diurnal acroparesthesia, its efficacy will be lower and there is a significant risk of evolution to a form presenting a deficit. Primary medical treatment or combined surgical treatment may be proposed according to the context.

In forms that are resistant to conservative treatment and advanced forms presenting a deficit, the recommended treatment is surgical. The contraindications against endoscopic surgery include:⁷⁶

- Motor form alone;
- Acute carpal tunnel syndrome;
- Hypertrophic synovial pathological conditions that require extensive synovectomy, and intracanalicular tumoral lesions;
- Poor visibility;
- Revision surgery;

- Forms with deficit in cases of a small wrist (risk of preoperative hypertension).

Persistence of symptoms, recurrence or new symptoms

In a recent analysis on the causes of reintervention surgery in 200 cases that were operated over a 26-month period, Stutz et al.⁷⁷ found that there was incomplete sectioning of the flexor retinaculum in 54%; perineural fibrosis in 32% (adherence to the anterior scar in 23% and circumferential fibrosis in 9%) and iatrogenic nerve injury in 6%.

In the absence of a proximal cause, three clinical conditions may justify reintervention after CTS surgery, with frequencies ranging from 0.3% to 12%, according to the authors.⁷⁸

Persistence of symptoms: This is the commonest complication after CTS surgery, mainly because of incomplete sectioning of the flexor retinaculum, most often in the distal portion. According to De Smet,⁷⁹ incomplete sectioning of the flexor retinaculum at this level is responsible for persistence of a positive Phalen test during the immediate postoperative period, absence of a free interval, persistence of symptoms and positive challenge tests. ENMG abnormalities may persist despite effective release, but ENMG normalization eliminates persistence of compression. Open reintervention surgery is justified in principle.

Recurrence of symptoms: After a free interval of several months (arbitrarily three), the symptoms may reappear at a time of trauma (fracturing of the wrist or of both forearm bones); a time of inflammatory crisis (tenosynovitis of the flexors); after healing and reconstruction of the flexor retinaculum; or after progressive imprisonment of the median nerve in a perineural fibrous scar, which is responsible for a syndrome of adhesions or Hunter's "traction neuropathy".⁸⁰ It was only this last etiology that Wulle⁸¹ considered to be a "real recurrence". In addition to recurrences of symptoms, a positive clinical examination may suggest that a syndrome of epineural adhesions is present. The ENMG results may again be abnormal. Procedures associated with new nerve releases in order to restore the glide planes between the median nerve and its area are often necessary, such as to construct a synovial flap,⁸¹ hypothenar fat flap,⁷³ pedunculated flap,⁸² biomaterials³³ or materials for preventing adhesions.⁷⁸

Appearance of new symptoms: These are mainly secondary to iatrogenic injuries that have occurred over the course of releasing the carpal tunnel. These may be in relation to nerves (trunk of the median nerve, thenar branch, palmar digital nerves or palmar cutaneous branch) or in relation to tendons. They may occur separately or in combination with one of the above two clinical conditions. Nerve repair of the terminal branches has the aims of enabling recovery of sensitivity and decreased neurogenic pain. In cases of neuroma of the palmar cutaneous branch, desensitization is indicated and, if this should fail, confinement. Repair of the thenar branch is indicated in cases of functional alteration with the potential for regeneration, according to the site injured.

Final remarks

Clinical knowledge about symptoms is decisive for implementing the most appropriate treatment, particularly in cases

of establishing how urgent surgery and postoperative treatment are. In addition, when some clinical treatments such as corticoid injection present positive responses, this may determine the prognosis for the surgical treatment and thus confirm the possibility of combining treatments for a better result for a particular patient, given his or her comorbidities. However, many procedures may lead to complications: among the smaller of these, neurogenic pain in the scar and pillar pain are the commonest types. Fortunately, although the major complications are more severe, they are rare. Thus, the decision regarding how to proceed after the diagnosis is the responsibility both of the doctor, in defining the best treatment options, and of the patient, who should be aware of all the complications possible from the treatment chosen.

Conflicts of interest

The authors declare no conflicts of interest.

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